

Creating a refurb nation

What's going on in the world of Victorian retrofit? Jo Moulds looks at the first retrofit project the Building Research Establishment has undertaken; a Victorian retrofit project by Camden Council, with research project UrbanBuzz, and a Victorian retrofit in Drayton Gardens, London, by Bere Architects ...

In 2001 there were just over 22 million households in England and Wales (defined as one person living alone, or a group of people sharing a living space). The government predicts this number will increase by 7% (1.6 million) by 2011 and 14% (3.15 million) by 2021. People use energy to heat and cool, light and power their homes, and energy consumption increased by almost 28% between 1970 and 2006. At the same time, many of us are living in what is deemed 'aging housing stock', and these properties are well-known for their energy inefficiency. So, we have a situation where the number of households is going up, with the number of inefficient buildings staying almost the same. What can, and is being done, particularly with regards to Victorian buildings, which are still the most common building type in the UK?

Rethinking housing refurbishment

The Building Research Establishment (BRE) has set up the project, Rethinking Housing Refurbishment. It is using a Victorian stable block building on its site at Watford and is refurbishing it as three demonstration buildings: Demonstration A, a ground floor studio style flat; Demonstration B, a two-storey house, with one bedroom as an example, and Demonstration C, a two-bedroom first floor flat. There will also be a 170m^2 extension for exhibition space, stairs and services. The existing building will also include a training room and a workshop with presentation rooms and studio above. Principal contractor, Wates Living Space, is backing the project, as are PRP Architects, EC Harris, Scott Wilson and RSK Environmental.

The idea behind the project is to;

- research what can be done with solid wall buildings to increase their thermal and overall environmental performance and ensure provision of digital services and climate change adaptation
- strengthen the economic, environmental and political case for retention and refurbishment of existing housing (rather than demolition)
- assist with training skills requirements to meet the demand and range of skills required in the housing refurbishment industry
- make information available via the website and on-site so that others in the construction industry can learn from a test-bed project. When the project completes in autumn 2009, there will also be detailed reports and guidance on sustainable refurbishment published in order to pass on knowledge.

The architects engaged by the BRE to work on the project are PRP, with consultant, David Housego, who was first approached in 2006 by Kate Symons, BRE associate director of refurbishment. Kate had previously worked with PRP on an in-house carbon zero competition with the Milton Keynes' PRP office. PRP submitted proposals to the Building Research Establishment in January 2007; grant funding was applied for in February 2007 and the East of England Development Agency (EEDA) agreed to support the project. Planning permission for the extension to the building had to be submitted since the building is within the greenbelt and there was an increase in the footprint of the building (because of the exhibition space extension) – this was granted in September 2007. Work started on site almost immediately. However, bats were discovered in the roof and so RKS Environmental was brought in to work on a bat Licence with Natural England (and Wates Living Space) in order to comply with changed bat protection legislation. This delayed the project slightly.

The building has many of the typical characteristics of pre-1919 housing. It featured asbestos, damp, settlement cracks, solid walls, single-glazed sash windows and a roof in urgent need of repair. Thermal imaging tests showed that the building leaked everywhere – there was virtually NO airtightness. It was decided to restore the single-glazed sash windows but with draught sealing and some secondary glazing for comparative testing. Various options for internal insulation are also being trialled, including a new and innovative aerogel product with extremely positive thermal properties. Thermal modelling indicated that there needed to be sufficient natural ventilation to cope with overheating and the use of an existing borehole for cooling to the north-east of the site is being considered. Smart metering will be fitted and a biomass boiler will be fed by locally-sourced wood pellets with gas condensing back-up boilers.

Once the building is completed, all natural paints and finishes will be used and furniture will be sourced using the FSC-certification scheme, where possible. There will be roof lights added to improve natural lighting, flooring will be timber and the ground floor will also be insulated. State-of-the-art water-saving devices are planned, including air-flush toilets and low-water spray taps and a shower that recycles water. There will be cycle storage as part of the external landscaping and a rainwater harvesting system. An unusual feature for an average Victorian building - a clock tower - will eventually by operated by a solar-powered clock motor. The building performance before and after is being monitored by BRE, including air tightness testing. The project is aiming for a SAP of 80 and a bespoke BREEAM rating of 'Excellent'.

This is not the only retrofit scheme included in

Above and inset: a Victorian stable block building on the BRE's site at Watford is being refurbished as three demonstration buildings: a ground floor studio style flat; a two-storey house and a two-bedroom first floor flat. There will also be a 170m^2 extension for exhibition space.

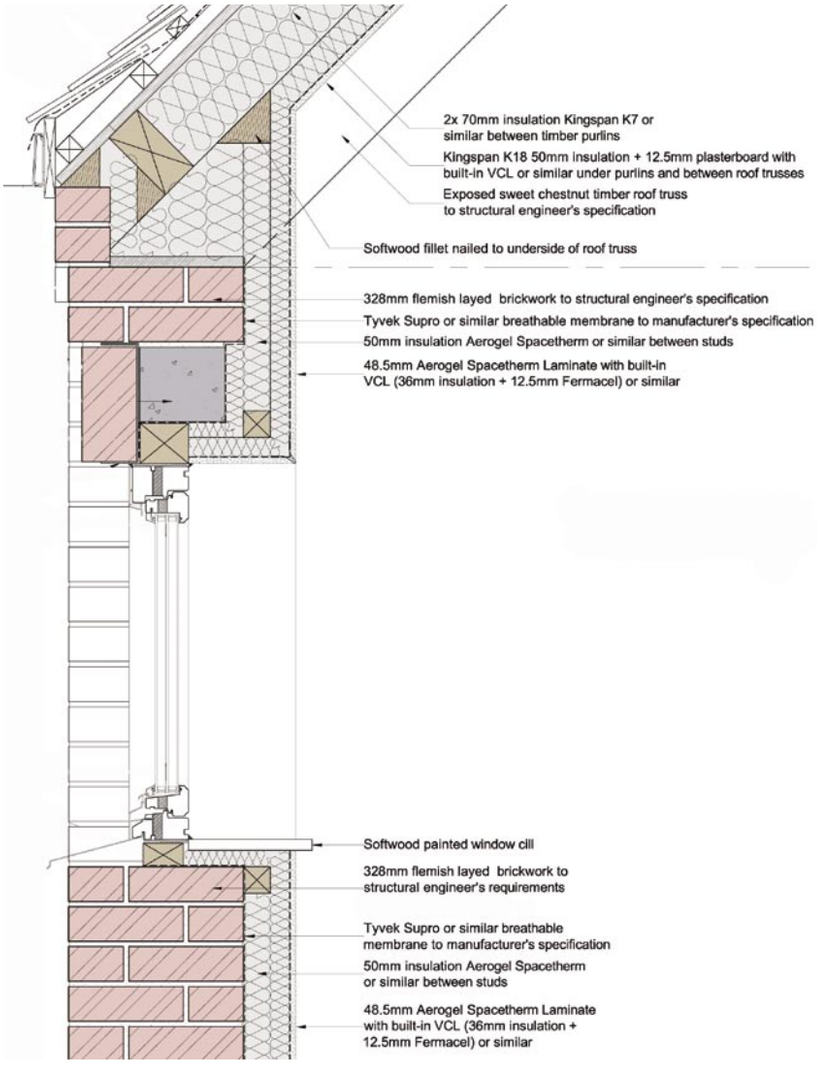
the Rethinking Housing Refurbishment programme. There are two houses in Sheffield and properties in Calderdale, Oldham, Rochdale, Huddersfield, Hull and others nationwide from HMR (Housing Market Renewal) Pathfinders regions which are being considered as potential refurbishment undertakings. Some of these are already inhabited and so will add to the fund of knowledge about how to go about eco-refurbishing while occupants remain in their homes. These projects are due to become live in 2009. Another connected project is CorRe, the Centre of Refurbishment Excellence in Stoke-on-Trent, Staffordshire. This was a Victorian commercial pottery building which is due to become part of the BRE's portfolio of demonstration projects, again showing the possibilities of Victorian eco-refit. The building will be used as a refurbishment training centre within the regeneration area of Stoke-on-Trent.

David Housego, the consultant on the projects, says: "We are so conservative in this country. The solid wall stock of our Victorian buildings is not easy to deal with environmentally and people do not like overcladding in the way that they will accept it in Germany. We need to improve so many thousands of buildings and people want to retain the appearance of their homes. It is a thorny issue and the Rethinking Housing Refurbishment project will add to the debate and offer education, training and potential solutions."

Refurb in Camden

There are 3.1 million dwellings in London and 56% of them have solid walls. These houses typically have double the carbon emissions of houses built to current regulation standards and it is often difficult to achieve a high degree of emissions' reduction. The borough of Camden is no exception and is accentuated by 60% of Camden's houses being within a conservation zone.

Below: section through the detailing of the roof, wall and eaves.



The Low Energy Victorian House Project, led by Camden Council, aims at refurbishing a solid wall semi-detached Victorian house located in a conservation area to achieve a 80% reduction in the house's carbon emissions. This project will result in low energy social housing for a large family, as there is a shortage of this dwelling type in most of the councils' housing stock. It also attempts to preserve some of the house's most important heritage features.

'Low Energy Victorian House: Towards zero carbon dwellings' is a project run by University College London (UCL) and London Borough of Camden (LBC) as part of the UrbanBuzz programme. The £400,000 project has taken over a six-bedroom council property in need of renovation in Camden, north London, with the aim of refurbishing it to a point where CO_2 emissions are reduced by 80%. The home, which originally had a separate basement flat and house, has been converted into one dwelling with accommodation suitable for a large or extended family.

The house was built in the 1850s, sits within the conservation area and so there are restrictions on how the house can be refurbished, especially externally. Prior to refurbishment work, councillors, construction and heritage professionals and academics all visited the house as a way of setting the project in context, helping stakeholders understand the project and "to involve them in a wider discussion about the heritage, technical, attitudinal and policy issues of emissions' reduction in period dwellings", says Chit Chong, acting energy and sustainability manager for Camden Council.

Ian Ridley, lecturer in environmental design and engineering at the Bartlett School of Graduate Studies, UCL, has been one of the academics involved to assess the energy performance of the house. External cladding was ruled out due to the conservation aspect (and the fact the house is semi-detached) and so up to 10cm of internal insulated plasterboard, provided by Kingspan Insulation, has been fitted on the front, rear and side elevations. Ian Ridley says this doesn't really cause any problems with regards to space in this particular Victorian property as the rooms are sufficiently large. Relative humidity and temperature sensors have been installed between the internal insulation and the external brick wall to monitor the risk of interstitial condensation.

The heritage value of the original dwelling was assessed by Oxley Conservation. The property did have the original cornicing but this has been removed and not replaced, partly because of cost and partly because the cornicing was damaged. Rob Simmons, lead designer from contract administrators Landers & Associates, says that the cornicing could not have been left in-situ because it would have affected the insulation performance. It would be possible to reconstruct the moulded original cornicing but, because of budget on this site, it was not feasible. Another original feature which was not replaced in order to make the insulation work effectively were the shutters. The original single-glazed sash windows have been replaced with double-glazed sash windows at a cost of £24,000 in line with the original style. Trickle ventilators are fitted in the windows to provide controllable background ventilation.

The house is heated using radiators fed by a condensing gas boiler. The fact that the radiators are now very small, compared to radiators you would expect to find in a house of this size, may surprise the public when they visit the house. This is because less heating will be needed as a result of the high insulation, again, bringing down heating costs and energy used. At one point, a ground source heat pump was considered but it was deemed too expensive and there was also concern about London Transport underground lines and other services underneath the house. Heating and hot water is provided by a 90% efficient gas condensing boiler in conjunction with 6m^2 of solar thermal panels providing additional hot water. There is a solar photovoltaic system and EDF will provide smart meters for gas and electricity. The UCL team's data logger measures relative humidity and indoor temperatures, and the smart metering system shows how much electricity is being supplied by the PV and hot water by the solar thermal system. The UCL team is gathering data monthly on behalf of London Borough of Camden and for UrbanBuzz and is also reporting annually, and will continue to do so for the next five years.

Under the floor in the basement, there is also two inches of insulation, again reducing heat loss. Overall, the

aim is to reduce carbon use from nearly 20 tonnes per year to 3.8 tonnes, a saving of over 80%.

	Pre refurbishment	Post refurbishment
Walls	2.1	0.2
Roof	1.9	0.1
Floor	0.5	0.2
Windows	5.0	1.5

U-values, W/m²K of the property pre and post refurbishment.

The garden has a water butt but a full rainwater harvesting system has not been fitted. In the bathroom, heat recovery extract fans have been supplied by Vent-Axia. The intermediate floors have remained, with extra steel support added to the staircases. The doors and staircases are all original. The property has been repainted using natural paints throughout and all newly fitted timber is FSC-certified. The roof insulation consists of two 75mm Kingspan insulation boards, with Kingspan nilvent breathable membrane between and over the insulation.

One of the aims during the refurbishment was to reduce the air leakage, making the house as well-sealed as possible. All chimneys were blocked and sealed and great care and attention to detail was taken by the contractors when fitting the internal insulation boards, to maintain a continuous airtight seal. Each internal insulation board was sealed with caulk, as were all service penetrations.

Air permeability at the beginning of the project was very high, with visible gaps and cracks in the roof and floor. The house was so leaky it was very difficult to carry out a fan pressurisation test, with the air permeability being measured to 30m³/hr/m² of external façade. After refurbishment, air permeability had been greatly reduced to 6.2m³/hr/m_2 of façade. Later this year, when the weather cools, a co-heating test will be carried out to measure the fabric heat-loss of the house.

Landers & Associates and the contractors Lengard have been on site from February to July 2008. The completed house is open to the public on Sundays from 2pm to 5pm, organised by the Sustainable Energy Academy (SEA) and Green Homes Concierge. These tours will be for a limited period before council tenants move in at the end of October 2008. For more information, visit **www.urbanbuzz.org.**

Below are some of the guide prices that this project worked within:

Solar PV system	£25,000
Solar thermal system	£8000
Double glazing	£24,000
Roof insulation	£6,600
Wall insulation	£11,000
Leakage reduction	£2,666

A private home retrofit in West London

Bere Architects, based in north London, have various experiences of retrofitting Victorian properties, including several homes on Drayton Gardens, west London. The particular property in question is a four-bedroom Victorian family house built in 1845. The project was for a family of four, with two children. The brief was to create a 'stylish new home' but the architects incorporated an "outwardly inconspicuous environmental approach," says Justin Bere. "I was able to bring in the environmental technologies and improvements mostly on the premise of health for the family, not necessarily around the environmental benefits."

The new technologies included on the retrofit have been a solar thermal hot water system, heat recovery ventilation system, internal insulation on some of the outside walls, double glazing where permitted and super-insulation on the new roof. Planning permission and listed building consent were required because of the internal alterations and because the house was being extended underground at the back and front of the building to incorporate nanny quarters at the front and a gymnasium and utility room underneath part of the back garden.

Because the house is Grade II listed, externally one of the most important issues was leaving the sash windows completely unaltered. Draught sealing was installed and secondary glazing installed inside. They are vertically sliding so that the view is completely untouched. They

On this particular project, the architect said that the conservation and planning officers were fairly sensible about solar panels (just noticeable in the inset photo). On a subsequent planning application in the same street, Justin has been able to show more reticent officers how little the solar panels were noticeable, although in fact, Justin prefers it when panels are noticeable as he feels it sends a signal to other houses that they could also be thinking of saving energy when they are refurbishing their properties.



cut down noise and dust and are good for lowering potential energy usage because a third of the heating bill is commonly caused by ventilation heat losses. The property needed repointing and Bere Architects specified the use of traditional lime mortar containing sharp sand, wire brushed to expose its gritty texture. Justin is always surprised by how many councils are insistent on picking up particular points with regards to listed buildings but then don't insist on using traditional mortar. "Many councils don't seem to care at all about the unsightly appearance of hard cement, even on listed buildings."

Iron railings at the front of the house and on first floor level were repaired and the roof structure was extended to heighten the attic room, in line with houses next door that had previously gained planning permission. Raising the roof level meant 'unusually high levels' of insulation could be installed: 30cm Foamglas, which keeps the building cool in summer and warm in winter.

On this particular project, Justin Bere says the conservation and planning officers were fairly sensible about solar panels. On a subsequent planning application in the same street, Justin has been able to show more reticent officers how little the solar panels were noticeable, although in fact, Justin prefers it when panels are noticeable as he feels it sends a prodding signal to other houses that they could be thinking of saving energy when they are refurbishing their properties. "These are beautiful buildings, worth conserving," says Justin. "We are updating them and I like to show that we are improving them environmentally. There is no conflict for me in retrofitting properties sensitively and at the same time showing that environmental adjustments have been made to give them a future in more environmentally conscious times ahead. Conversely, if we hide away the solar panels, we are missing the opportunity to prompt the neighbours with an important environmental message."

Internal insulation was also fitted on this building and, in this case, the relationship of the historic cornicing and the wall was unaffected. For this project, Bere Architects specified the use of plasterboard where permitted to the inside face of the external walls but Bere is hoping to use an Austrian/Swiss vacuum insulation product on his next project on Drayton Gardens. This is a very thin insulation product which is 8-10 times as good as normal insulation and of ecological manufacture, according to Justin. This means 2cm of insulation is equivalent to 16cm of insulation and his intention on his next project, subject to client approval of the cost plan, is that the next house will be close or even reach passivhaus standards - again this will be a Victorian property. They are having problems with the planners, at the moment, not wanting them to replace the existing plaster, even though, Justin argues, this is already modern plaster, not original. Eventually, he hopes, they will gain permission to replace the existing 40mm of plaster with 20mm of vacuum insulation plus 20mm of plaster. Justin warns, however, this product, new to the UK, is at present very expensive and it must be manufactured to the exact shape required as it cannot be cut or punctured otherwise it will lose its insulation properties. This also means that with internal insulation, holes cannot be drilled into the walls unless they are in pre-planned positions.

When Justin is working on refurbishment projects, he also likes to suggest that clients incorporate native planting, although they don't always agree. "In my new home, we have a mixture of wildflower meadows, hawthorn and hazel planting that creates a little nature reserve that is excellent for British wildlife. Some clients are keen but I haven't convinced them all as yet." Another bugbear of Justin's at present is London front gardens that have been paved over. "If people planted instead of just paving over, this would improve natural drainage and help wildlife. Paving over gardens is wrong because it tends to put a lot of unnecessary water into the drains which causes flooding elsewhere so it should be banned, but the government just doesn't seem to give a damn."

The client in the Drayton Gardens' home accepted quite a lot of Justin's environmental suggestions, even though this wasn't part of the main brief. The children of that household may not be aware of the insulation in the walls but they will grow up with the technologies installed which they will probably see as quite normal. Justin feels that while it is often difficult for the present generation to accept the need for all his suggested environmental improvements, it is worth going as far as the client will agree to in order to help make this approach familiar and acceptable to the next generation who will find it easier to give priority to caring for the environment at the same time as creating a beautiful home.

The potential energy savings of careful design work are large but how much is saved also comes down to client behaviour. People need to learn to switch lights off, use fewer lights or even read a book by natural light in a chair by the window, not have the hot water set higher than required by health regulations, and just be aware of their surroundings and how to reduce the energy use of their homes and save water.

Jo Moulds

Thanks to:

Ian Ridley; Chit Chong, Peter Morgan, Rob Simmons, Stephanie Matthews, Lucy Tennyson, David Housego, Justin Bere and others.

Useful links

Rethinking Housing Refurbishment www.rethinkinghousingrefurbishment.co.uk

Urban Buzz www.urbanbuzz.org

Bere Architects www.bere.co.uk

The Victorian Society www.victorian-society.org.uk

The low energy Victorian House www.levh.org.uk